

Thermal Performance of External Renders Applied to Concrete Blockwork

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1 Introduction

The aim of this study was to investigate and analyse different external renders, available locally, and to study how their use may enhance the overall thermal performance of local concrete blockwork. This study provides an insight into how the various types of renders available improve the U-value of a concrete block wall. Three main types of external renders were used as the basis of this study. Results demonstrate that the 'glass fibre additive' type of render helped to greatly improve the U-value of a bare concrete block wall. This enhanced U-value, however, is achieved using more expensive render systems. Thus, from this study, the energy conscious designer can assess how, with the help of specific external renders, a more energy efficient building could be achieved, or how an existing building's thermal efficiency could be improved.

There are three aspects of performance that inform the selection of an external finish, namely:

- Aesthetic quality (colour & texture);
- Cost effectiveness, as compared to other types of finishes;
- Resilience to adverse weather conditions, particularly thermal performance.

This paper investigates the issues relating to thermal performance, but also highlights the cost associated with choosing alternative but similar renders.

2 Background

Malta is a typical Mediterranean Island, with hot dry summers and warm wet winters. It also has windy conditions, all year round, particularly along the coast. Rendering mortars with typical local mix designs often prove

insufficient to combat the convective cooling of such severe winds. Over the last decade, imported admixtures or pre-prepared composite renders have been used in applications to local blockwork walls. Blockwork walls have recently become the more popular material for masonry construction, exceeding the use of indigenous globigerina limestone. Hence the application of an effective render to the otherwise highly porous blockwork is even more important.

3 Renders Used for Tests

In Malta, the conventional cement-based render is widely used, since it is still the cheapest to buy, and since it can be used as a substrate for other systems, for example, with another thin silicate or polymer render finish applied to it. Renders are still considered as merely surface finishes, and therefore The cheapest possible product, with the best visual effect, is sought.

Since there are basic similarities in all the ranges of products offered by the different companies, it was felt that it would not be useful to study similar types of render from different companies. Italian products were used for the tests, imported by a local company. This company was interested in the opportunity to carry out experimental studies on their products for the local construction industry. This Company also test their renders in Sicily, a climate very similar to that of Malta.

3.1 Render Descriptions

The choice of render system was based primarily on their widespread use, locally, and secondly because on the insulating properties claimed for their products.

Three types of renders were used, namely a cement-based mortar mix, here called render P1, a porous dehumidifying, macroporous mix, here called type P2, and a smooth finish polystyrene mix with a glass fibre mesh reinforcement, here named render P3. (To conform with trade secrecy, no mix design is divulged by the company; similarly no brands or importers' trade names are included in this text).

The products used were:

P1 – pre-mixed cement base mortar. This is the most popular render and, since it is pre-packed, it ensures speed in carrying out the work, with guaranteed results and constant quality on site. This render is usually applied at 6–7mm in thickness. Also, polymer-based resin additives may be added to the mix, to achieve different qualities required, such as waterproofing or increased elasticity.



Fig1: P1, sand and cement mix

P2 – this render is said to be an ‘*advanced-technology dehumidifier*’ because of its macroporous structure, the render also has low thermal conductivity, thus improving the thermal insulation of masonry. This render can be applied in layers of up to 25mm thickness for maximum insulation efficiency.



Fig2: P2, macroporous mix

P3 – this system consists of a smooth finish adhesive, polystyrene foam and glass fibre mesh covered again by the smooth finish adhesive. A final finish coating is applied over this system. This thermally-insulated façade system can offer many advantages, apart from offering a very fast way of thermally insulating a building. As a result, the interior face of the wall does not cool down much, stopping unwanted condensation, dampness and mould.



Fig 3: P3, polystyrene and glass fibre structure

4 Experimental Methodology

The intention of this study is to carry out comparative experiments on various types of renders applied to concrete block, whilst still keeping to the guidelines recommended by the Euro-code as specified in EN ISO 8990:2000 (MSA, 2004), but at the same time achieving results that would really represent what actually happens on site of newly built or renovated buildings.

It was decided (after analysing many methods) that the best test method in order to minimise all these losses, and to ensure that all the heat (Q) supplied, only passed through the test blocks, was to build small concrete block 'cells'. In doing so, heat losses were minimised and controlled. The whole internal area (A) of the 'cell' was taken into account. This method is based nonetheless on the test procedure given in the Euro-code EN ISO 8990:2000 (MSA, 2004).

The success of the experiments depends on the heat supplied (Q) which flows laterally through the wall area (A) to the outside (cold side). Therefore it was very important to minimize heat loss from any other areas of the experiment set-up by applying thick insulation at the top and bottom of the cells. If heat losses were significant, even through the insulation itself, then the results could be very misleading, or completely wrong. Special care was taken, when designing the test procedure, to ensure that the different tests could be carried out in exactly the same way, so that if some heat losses were unavoidable, this would be a constant throughout all the different tests.

5 Test Procedure

Four cells were built from the concrete blocks provided. These measured 1150mm x 920 x 520mm. These were built on insulation panels 120mm thick, and elevated from the ground to ensure a good insulation barrier beneath the cell. The top of the cell was roofed with 300mm thick insulation mineral fibre insulation(Rockwool©) to minimise heat losses from the top. The internal face of the cell was left bare and the external face was applied with the different types of renders. In this way, since the top and bottom of the cell were well insulated, heat only flowed laterally through the concrete brick walls and render to the outside.



Fig 4: Thermocouples fixed into position on 'hot' face

Two 10mm diameter holes were dug through the base insulation, to allow the passage of the thermocouple wires, as well as the wires leading to the resistors and light bulb, from the inside to the outside of the cell. The two holes were dug as distant from one another as possible so the higher voltage passing through the wires leading to the resistors would in no way interfere with the milli-volts passing through the thermocouple wires. A higher voltage passing close to the thermocouple wires, could affect the voltage induced with the wire, and therefore a wrong reading may result or different readings may be read for the same temperature.



Fig 5: Thermocouples fixed into position on 'hot' face

Each thermocouple was clearly labelled according to its assigned channel to avoid confusion when moving the sensors from one cell to another. This also easily helped to identify which sensor may be defective in case of abnormal readings.



Fig 6: Thermocouples labelled according to their respective channels and connected to data logger

5.1 Insulation Sandwich of Cell

Great care was taken to ensure that heat loss from the inside of the cell was minimal from the top or bottom of the cell. This was to ensure that heat could flow laterally through the concrete block and render. The cell was built raised off the ground and on an insulation panel 120mm thick. The insulation panel and the air beneath the panel provided an insulation barrier.



Fig 7: Cell sandwiched between insulation

6 Tests and Results

Fourteen tests were carried out in total, which comprised of 704 hours of testing time. Three tests were carried out on each cell, but the first test of each set was discarded, because they were presumably too short, and the results achieved, when compared to the results of the subsequent two tests carried out,

were not so close. This trend was seen in every set of results. This may have been due to the fact that during the first test run, the cell had higher moisture content, since the environment in the laboratory was quite damp, and also the bricks may also have been slightly damp from the application of the renders. Therefore the first test was used to 'stabilise' the cells for the following tests. In total eight tests were considered valid, and were in line with EN ISO 8990:2000 (MSA, 2004).

A graph was plotted by the computer software throughout the duration of the test, to help verify the time at which the steady-state had been reached. The tests were frequently inspected, to ensure that all was proceeding well, and that the readings made sense. Final readings were taken when at least two successive readings spread over three hours after near-stability had been reached, and agreed within 1% (MSA, 2004).

A summary of results is outlined in table 1:

Table 1: U-values in W/m^2K .

Cells A,B,C with respective render applied.

Cell / Render type	Bare Cell	Cell A	Cell B	Cell C
Bare Cell	4.78	-----	-----	-----
P1	-----	4.63	-----	-----
P2	-----	-----	3.61	-----
P3	-----	-----	-----	2.01

Using bare cell (non-rendered) as reference, the percentage decrease in U-value due to the applied renders were 3.14%, 24.58%, 57.95% for P1, P2 and P3 respectively.

7 Scope for Further Research

Stemming from this paper, one area that merits further research is the investigation of their embodied energy for the given conductivity they achieve.

8 Conclusions

Render P3, reduced the U-value by almost 58% over bare blockwork. However this financially costs the most out of the three, standing at $€70/m^2$ compared to $€47/m^2$ & $€14/m^2$. This additional cost difference is

deemed a worthy investment, as buildings would be losing less heat through the fabric in winter, thus making them more sustainable. Due to the fact the Malta has to import fossil fuels, these initial investments are becoming ever more relevant given today's ever soaring price of energy (record high price of oil at \$118/barrel-Apr08).

Rendering may also be considered as a valid alternative to cavity insulation, particularly if the embodied energy of the render is compared to an insulating material to achieve the equivalent U-value.

References

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